Master's Thesis

MuScale: Designing for Tangible Interaction with Weight in Digital Music Experience

Ha yeon Choi

Department of Creative Design Engineering

Graduate School of Creative Design Engineering, UNIST

2020

MuScale: Designing for Tangible Interaction with Weight in Digital Music Experience

Ha yeon Choi

Department of Creative Design Engineering

Graduate School of Creative Design Engineering, UNIST

MuScale: Designing for Tangible Interaction with Weight in Digital Music Experience

A thesis submitted
to the Graduate School of Creative Design Engineering, UNIST
in partial fulfillment of the
requirements for the degree of
Professional Master of Design-Engineering

Ha yeon Choi

01/02/2020

Approved by

Advisor

Chajoong Kim

MuScale: Designing for Tangible Interaction with Weight in Digital Music Experience

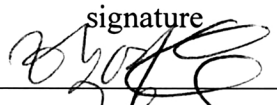
Ha yeon Choi

This certifies that thesis of Ha yeon Choi is approved.

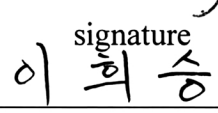
01/02/2020 of submission

signature 

Advisor: Chajoong Kim

signature 

Young-Woo Park

signature 

Hui sung lee

three signatures total

Executive Summary

Nowadays, music streaming services have been most widely used thanks to digital technologies advanced. As physical format (vinyl, tapes, CDs and DVDs) gives way to digital delivery, it also deprives experiences that people used to have in music listening experience such as loss of attachment to and dehumanization of music. Based on this background, the purpose of this study is to explore how to give ‘physical properties’ to intangible data to recover “psychological ownership” such as effort and confidence. Our main question is how psychological ownership appears through the combination of digital music and tangible weight. For this study, we conducted a user study with "MuScale", a research product created through interviews and concept selection. Six participants used this product for two weeks. MuScale has introduced a way to sustain the value of digital music through the concept of ‘psychological ownership’ of digital content. First, while experiment, participants represented desire to create additional music cube or complete playlist through modifying. Second, they satisfied managing their mood through controlled atmosphere and reflected potential goals for their daily life. Reflecting potential goals on the three different weights can lead to increase psychological ownership of digital content by inducing 'self-reflections' that allow one to realize the user’s intentions in the content consumption process. Third, we could find that a MuScale used as a communication tool. MuScale was a method for a conversation which provided a positive experience and the desire to use it in a more social context in the future. From these, we could make a conclusion that four aspect of psychological ownership appears various phenomenon. Combining tangible weight with digital music contents is a new way to improve achievement through reflect potential goals. And through this study, we provided designers with the possibility and opportunity to materialized their tastes and lifestyles in a sharing context.

Keywords: Music, tangible interaction, rematerialization, weight

Contents

Figures

Tables

Chapter 1
Introduction

1.1 BACKGROUND

In our daily lives, music is mainly used for emotional values. Music increases relaxation and positive feelings in our daily life while a long time. And many people think of music as pleasant (Kallinen & Ravaja, 2004; Scheel & Westefeld, 1999). After many forms of development of music, streaming services have been popularly developed today; Vinyl music, cassette tape, smartphone music platform (Figure 1). Music streaming service provides library based on the internet network. If the consumer paid for service, they can access the music anytime, anywhere. Morris and Power explained that these streaming services provide not only high autonomy and accessibility, but also data-based information about user's listening habits (Morris & Powers, 2015). Belk explained streaming service is a subscription business model that provides instant data. And he defined that this model is 'post-ownership economy' (Belk, 2013).

Figure 1 Development stage of music player

Although, several researchers argued that these features of streaming services led to some problems. as the process of listening to music is shortened, users lose their emotional attachment (Brown & Sellen, 2006), have lost their association with music contents (Bartmanski & Woodward, 2015). Maguadda argued that listening activities using only digital displays lost the meaning and cultural value of music. He explained this phenomenon is 'dehumanization' of music (Magaudda, 2011). Bartmanski argued that digital music consumption has reduced awareness of 'ownership', and it led to the loss of relationships with music products (Bartmanski & Woodward, 2015). Sinclair and Tinson explained the loss of value of music, because of the reduction of psychological ownership (Sinclair & Tinson, 2017).

1.2 RESEARCH AIM AND QUESTION

Interaction with data is inevitable in modern society. In the field of HCI including design, research and importance of data-human interaction are emerging. Odom emphasizes the need for research into the direction of digital possessions, despite the rich opportunities of digital content. He suggested the restoration of relationships between digital content and humans through that virtual possessions, like physical possessions, can be used to realize identity and aspirations, and can be mediators of social connections (Odom, Sellen, Harper, & Thereska, 2012). Besides, according to Vande moere, researchers and designers must focus on the design of data presentation (Moere, 2008). Jansen and Dragicevic argue that visualizing intangible data is a human-centered solution to the problems associated with data interaction (Jansen & Dragicevic, 2013). Odom emphasized the need for simple access and a new approach to personal digital content experience (Odom, Sellen, et al., 2012). Against this background, the purpose of this study is to explore how to give 'physical properties' to intangible data to recover "psychological ownership" such as effort and confidence based on emotional attachment. And then, ultimately connect digital content with users. (Figure 2)

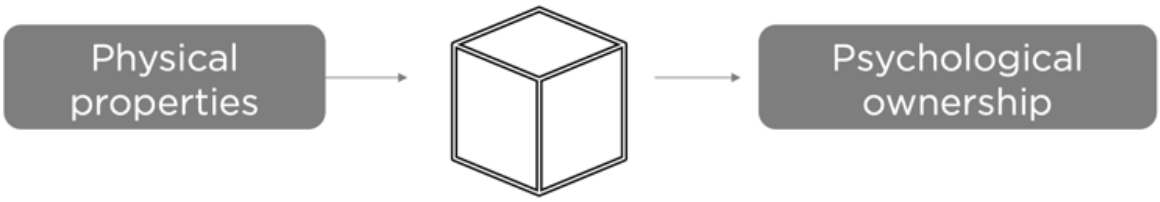


Figure 2 Aim of this study

For this, we tried to find the value of music by giving the intangible music data the property of 'tangible weight'. Our research questions for this is as follows:

- ✓ How would tangible interaction with weight be related to psychological ownership in music listening experience?
- ✓ What other experiences would people have interacting with weight in the situation?

For this, our key questions for this is as follows:

- ✓ When reflecting weight on the playlist, what value/meaning will people reflect?
- ✓ If tangible weight affects psychological ownership, what factors directly affect?

To explore how to recover emotional attachment of digital contents, we introduced the consumer concept of 'psychological ownership' and the physical property of weight. Case studies using these concepts and physical elements were explored in the literature.

Chapter 2

Literature study

2.1 PSYCHOLOGICAL OWNERSHIP

Psychological ownership is a comprehensive notion of Pierce. it has a different meaning with possession. He explained that when satisfied three factors – reflecting their personality, intimately knowledge and control the target, the user has a desire to invest in the target. He defined psychological ownership as the pleasure or positive effects when the environment or mood is managed as the user's favor (Pierce, Kostova, & Dirks, 2003; Watkins, Denegri-Knott, & Molesworth, 2016). Figure 3 shows this theory of psychological ownership (Jussila, Tarkiainen, Sarstedt, & Hair, 2015).

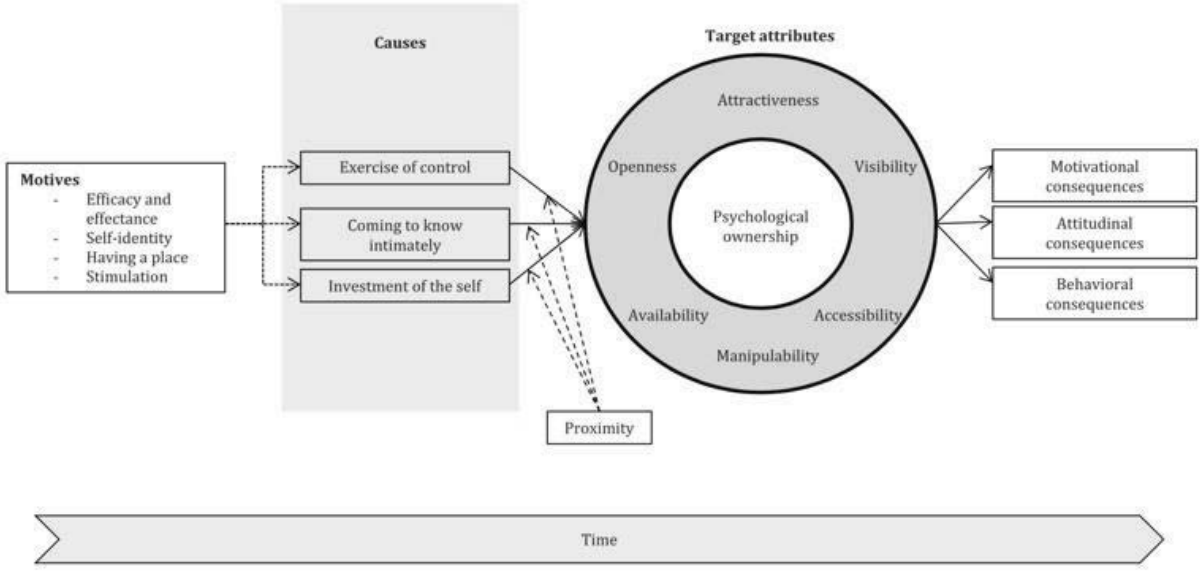


Figure 3 Theory of psychological ownership in marketing context

Sinclair and Tinson are explained that psychological ownership appears in four aspects of music consumption: Materiality, loyalty, Empowerment, Social rewards.(Sinclair & Tinson, 2017)

- ✓ Materiality: Originality given by real objects. Importance of material possessions
- ✓ Loyalty: Comes from familiarity. Include using the same platform because of the familiar interface or buying a CD because the user feels that supporting the artist
- ✓ Empowerment: Used for managing feeling and mood in everyday life. This includes creating a playlist that fits your particular situation and mood.
- ✓ Social rewards: Confidence gained through sharing with others. Proudness by expressing

user's own personality, taste.

In particular, the importance of materiality is frequently addressed in previous studies. Skågeby explained that the materiality of music provides a more focused listening experience. He explained this opinion with example-cassette tapes, that things like size and shape include real aesthetic value (Skågeby, 2011). Magaudda argued importance of materiality through comparison LP with digital music data. He explained that materiality of music created listening habits and iteration when they are listening to music. But digital music data has no new stage after 'save to playlist'. Figure 4 explain the stages of music consumption through vinyl and digital music consumption. In the case of digital music, consumer back-up the music data to the new music storage devices, and as their attachment of music data changes, the behavior of storing music changes. On the other hand, in the case of vinyl music, as users' listening habits changed, they reintroduced the authentic value of vinyl records. It led to consumption such as buying new and listening to vinyl records. Like this, many researchers emphasized important of materiality in music contents for valuable listening habits.

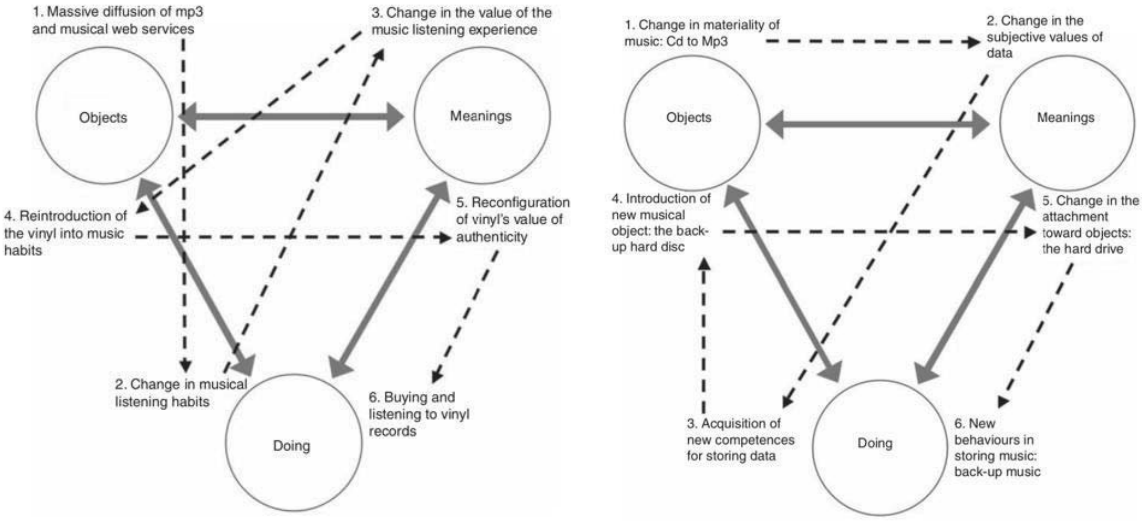


Figure 4 process of performative re-integration of vinyl records in musical consumption and integration of digital music with hard disk in music consumption (Magaudda, 2011)

2.2 MATERIAL EXPERIENCE: REMATERIALIZATION

Researchers have suggested the importance of Tangible interaction through the physicalized data for a new experience of digital content. Hornecker emphasized that physics is the center of embodiment interactions, and that humans' pursuit of physical experiences is inevitable, and designers must use physical experiences and information through concrete interactions (Hornecker, 2011). Giaccardi and Karana propose a material experience framework (Figure 5) that allows us to explore and develop unexpected experiences based on the aesthetics of experience and the essential properties of materials. (Giaccardi & Karana, 2015)

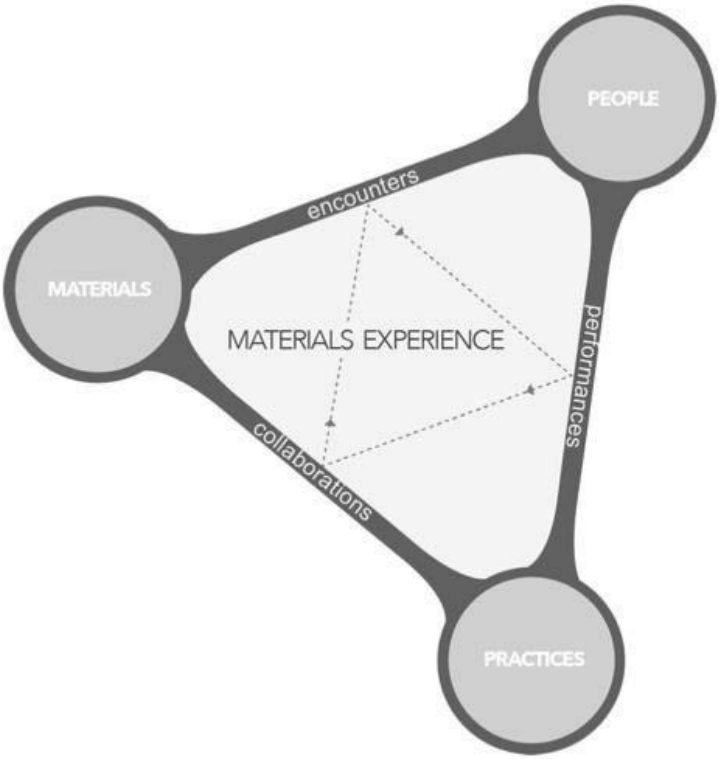


Figure 5 The material experience framework (Giaccardi & Karana, 2015)

2.3 RELATED WORKS

Spotifybox (Parra, 2011) is a product for economical production rather than service. That based on 'Spotify' that music streaming service platform. She uses eight token that has a shape of a little CD. Music tokens are linked with user's flavor and attach the player like with mixtape (Figure 6, left). Qleek (Ozengestudio, 2014) focused on the importance of material and presenting personality. They have a compact size and visualize album art. Users can collect and display their hexagonal flat cube, and then they can present their flavor (Figure 6, right).

Figure 6 Spotifybox (parra. J, 2011), Qleek (ozenge studio, 2014), Muredder (Kim, Jang, Kim, Kwon & Park, 2019)

The third example is muRedder(Kim, Jang, Kim, Kwon, & Park, 2019). That is a one-time music

ticket that takes a metaphorical interaction of shredder. Their study is that induces a prudent listening experience by utilizing the value of an analog listening experience. Interestingly, participants tend to find a place or time for listening to music. They focused on one-time music tickets(data), which are disappear when played. Our study will apply the concepts of stable data and measuring psychological ownership.

Figure 7 (a) Co-housing radio (b) Physical RSVP (c) Participants scale

Jenkins has created three prototypes with physical properties for the development of social relationships through the IoT system in co-housing. Co-housing Radio provided a channel for residents to share their stories and encourage discussion through music. Physical RSVP provided management of events, invitations, and responses in the community through a physical method such as 'voting'. Third, Participants Scale is a weight scale that indicates the level of participation of residents. According to the researchers, the third prototype using weight was used as a tool for 'self-management' rather than a penalty, and the act of lifting weights on the scale was defined as a 'symbolic behavior' of investing in the community'. They used these three physical prototypes to improve the relationship in the social context (Jenkins, 2018)

2.4 CONCLUSION OF LITERATURE

From previous studies, we found insights. First, to develop comprehensive psychological ownership of music in spite of being intangible, it is necessary to construct a scenario in which the user can control the environment as they want by reflecting taste and identity based on their own experience.

Secondly, for these three conditions, Giaccardi and Karana's emphasis on materials, practice, and user interaction should be considered. The team designed the experiment based on the question of how to explore unexpected experiences and values through the rematerialization of musical data based on an interactive framework of three elements: material, practice, and people (Figure 5).

Third, in related studies, researchers induced personality expression and careful listening experience through physical properties and metaphorical actions such as mixtape, shredder, and analog

scale(balance). Jenkins clarified that using a physical property in cohousing encouraged social participation and defined another meaning to “weighting”. We found that the meaning of weight and when it was physically provided to the user gave a new meaning to the behavior, and we applied the physical property of 'weight' to our research topic.

Our study will assign an essential property of weight that tangibility and relativity to a token containing data, and design three scenarios for psychological ownership through metaphorical interaction

Chapter 3
Experiment

To find the answer to the research question, we designed experiments (Figure 8). First, (1) experiment stimuli were created based on the above background. Secondly, (2)a focus group interview was conducted to find directions and standards for a research product based on three experiment stimuli. Before creating a research product, (3) pre-interview examined how people matched playlists by weight. (4) Research products were created and (5) Field studies were conducted to six participants.

Figure 8 Experiment design

3.1 PRELIMINARY STUDY

We interviewed people to find out what patterns they matched when they reflected their weight in the playlist. We recruited 20 people using streaming music services. Their age is between 23 to 34, and they had various jobs such as student, designer, editor, an office worker. We requested for two tasks to discover the mapping pattern. Interviews were recorded and reported anonymously for the privacy of participants.

- ✓ Categorize into 3 groups based on experience among your playlists
- ✓ Match each group by weight

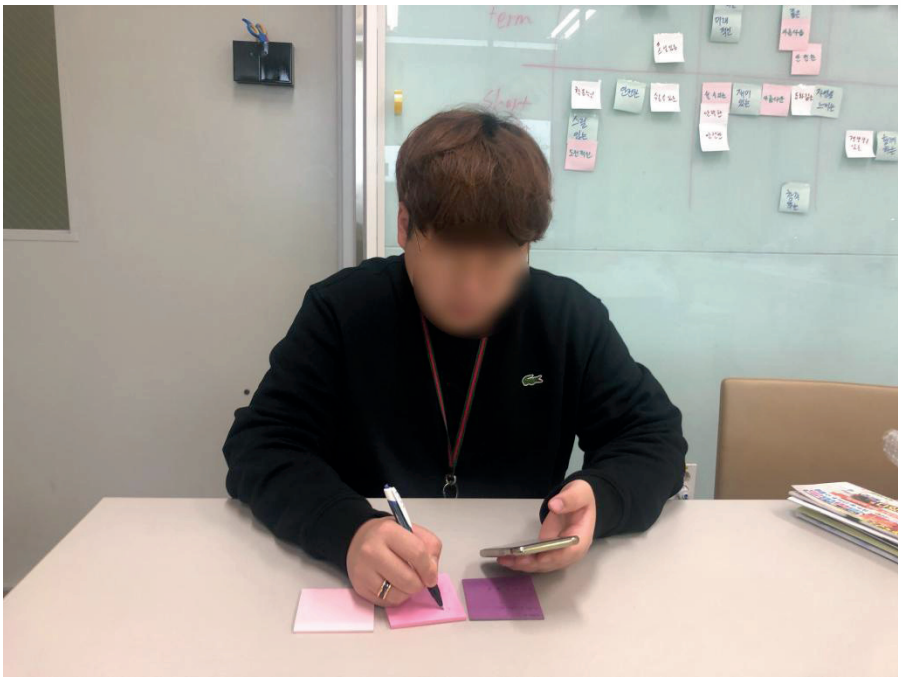


Figure 9 Preliminary study

Questionnaire

We provided several simple examples for those who have difficulty with categorizing: experience, flavor, person. After activities, we ask these questions:

- ✓ When did you listen to the song?
- ✓ Who has related this playlist?
- ✓ Why did you choose these songs?
- ✓ What kind of situation do you listen to?
- ✓ What are the reasons and standards for matching (light – medium - heavy) weight?

Result of preliminary study

First, most people associated their light weight to the songs they enjoyed with their 'friends' (65%), 'brighten up the mood' (60%). 13 participants were associated with their friends. Then answered 'family', 'me(participant)', 'lover'. In the context of listening to that playlist, 12 responded by brightening up the mood (60%). And then, followed by 'pleasant memories' (30%), and 'working' (10%).

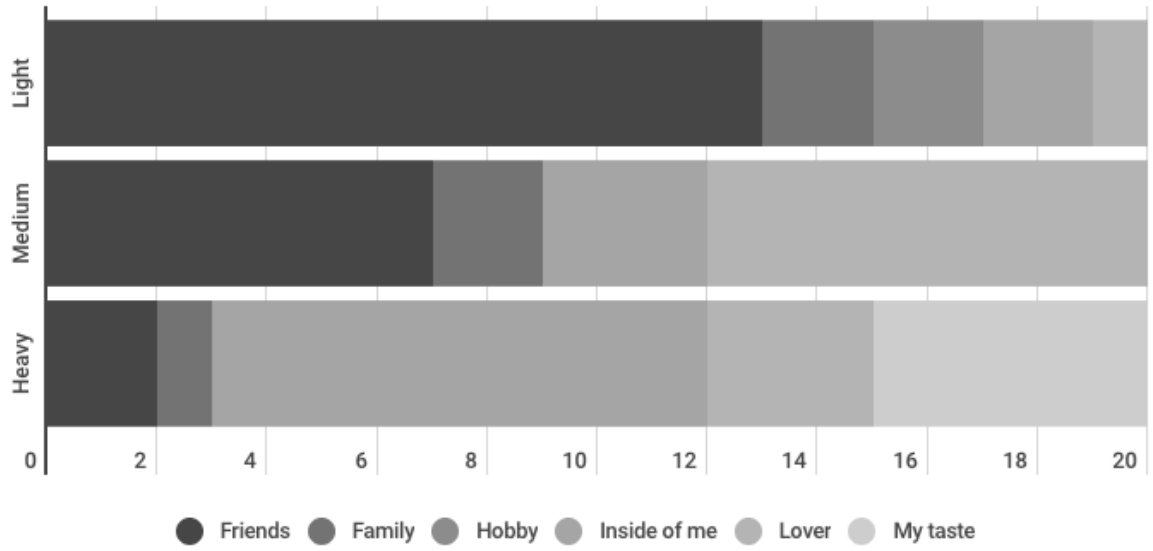


Figure 10 Associate target with each weight

Second, the medium weight tended to connect with ‘lovers’ and ‘reminiscence’. Eight people said they were ‘lovers’ (40%), and then followed by the’ friends’ (35%),’ inside of me’ (15%), ‘family’ (10%). Interestingly, some participants said that reflected tension of relationship.

Third, the heaviest weight was associated with the ‘playlist about the participant's personality’ (60%) and a play for ‘encourage’ (40%). Nine people said it was a song that represented me, and four people answered that their flavor was a strong reflection. Then followed by ‘lovers’ (10%), ‘friends’ (5%) and ‘family’ (5%). Seven participants replied that they were playlists for their ‘encourage me’ (35%), and six respondents played when they ‘recalled the time they liked the song’ (30%).

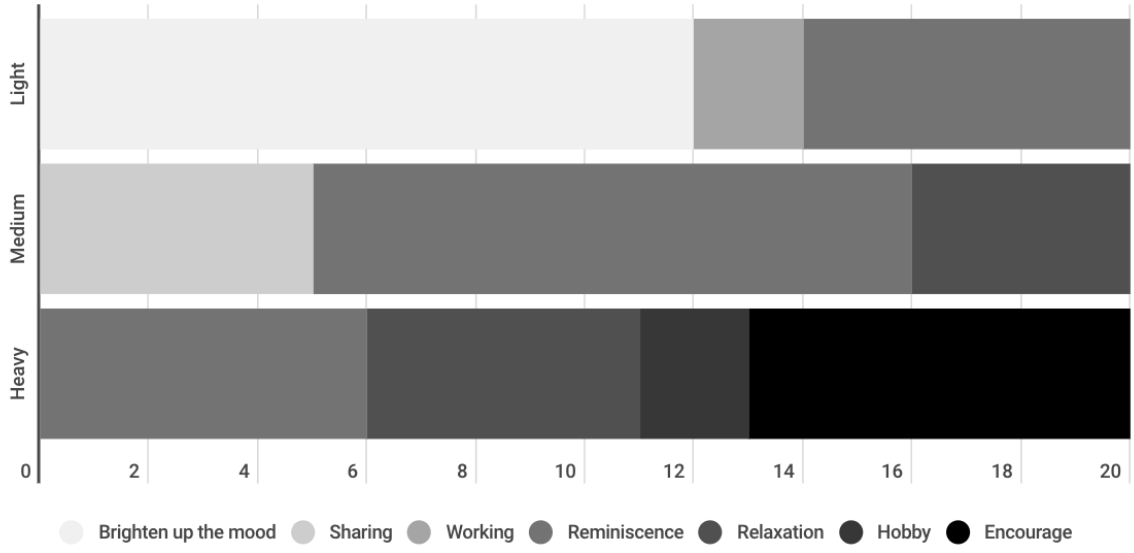


Figure 11 Listening context of each weight

Finally, as a standard for weight, People mapped on various standards. Eight participants classified the weight according to ‘accumulation of experience’ (40%). In detail, it was divided into lifestyle accumulation, a reflection of an inner mental state, and music experience formation. Six participants then answered ‘relationship’ (30%). Among them, four people answered, ‘tension of relationship’, and then 'physical distance', and those who chose is followed (Figure 12).

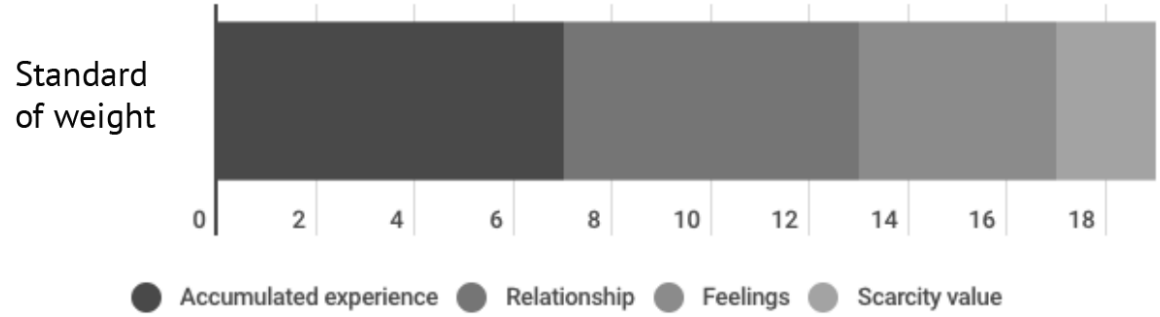


Figure 12 Standard of categorization by weight

Conclusion of preliminary study

From the interview, Then, we could figure out that the heavier the weight, the more the psychological state is reflected. First, we found that physical distance between relationships is reflected by the weight stage. The heavier the weight, they tended to narrow down their psychological distance from friends to themselves. The lighter the weight, they associated with the more fun and enjoyable experiences with friends. The heavier the weight, they associated with the experience related to the inside of themselves (Figure 13).

The research team designed the research product based on the above concept to apply this pattern to the weight of the type and explore how it would interact with the user in real life.

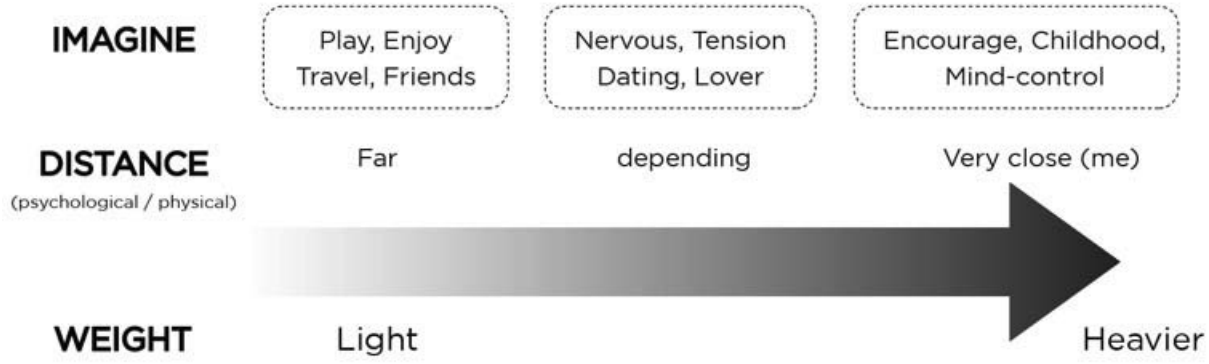


Figure 13 Patterns for things that connect by weight

3.2 IDEATION OF EXPERIMENT STIMULI

Skageby proposed a playlist with various values, and we wanted to explore the weight of that value (Skågeby, 2011). In the process, we wanted to design a device that weighed value. For the design of these devices, based on the three conditions of psychological ownership presented by Pierce (Figure 3) and the framework proposed by Giaccardi (Figure 5), the following design guidelines were established, and proceeded to concept development.

- ✓ Playlists should be able to contain the identity and taste of the user.
- ✓ Playlists should be able to reflect the experience of the user.
- ✓ The device must be an intuitive interface that is easy to interact with the user.
- ✓ Users should be able to touch and feel the weight directly.
- ✓ The device should provide feedback to the user according to different weights.

The three design concepts that have evolved on this basis are classified based on the following two criteria.

- ✓ Tangibility of weight: virtual weight and tangible weight
- ✓ Contents that provide to the user

Generated idea

The experiment stimuli are divided into three concepts according to the method of weight and how the user interacts with it. Firstly, Concept A is using virtual weight. Concept A (Figure 14) has one artifact. Users can control the virtual weight; they can feel different in weight depending on the moving controller of the device. Secondly, Concept B is using tangible weight. Concept B interacts between tangible weight with the user. Concept B consist of a player and several playlists. Playlists have each different weight. The device can provide visualize for each tangible weight. Concept B provides material experience directly rather than other concepts. Third, concept C uses a tangible weight. Way to interaction is the same with concept B. Concept C provides the new playlist to the user when they combine each different cube. Concept C can imagine printing bills. If the user inserts the playlists, the player provides a new playlist that combining weight. We considered the recommendation system of streaming service.

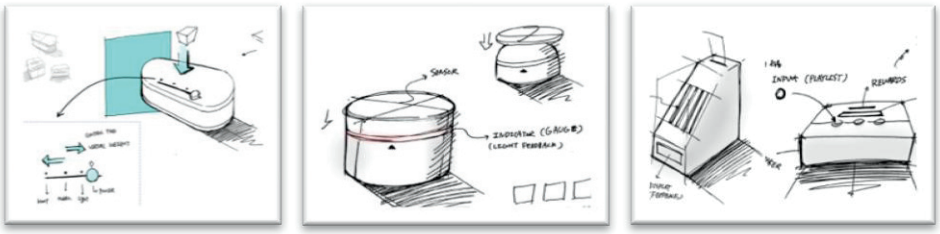


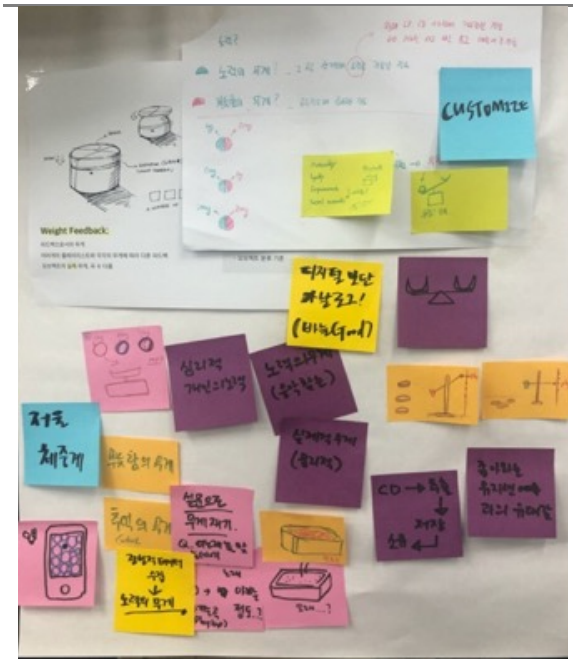
Figure 14 Idea sketch of concept (A, B, C)

Evaluation of the ideas

Based on three different concepts of experiment stimuli, we conducted a focus group interview to find out how to use weight and a basis for weight to feel psychological ownership. The purpose of a focus group interview is that (1) how to apply weight for psychological ownership; (2) exploring the standard by which users match weight in playlists. Three graduate students (two master course students and one ph.D. student) were recruited for focus group interviews. Their majors were design and engineering. The interview was conducted in a comfortable atmosphere to discuss their idea. This session was recorded for analysis.

Participants were free to discuss each background idea. First, about ‘how to weight should be used in playlist’, they commonly said that using real weight would be effective in connecting users with music. Besides, regarding concept C, they responded that it was an interesting and trendy idea in terms of 'deleting playlists and organizing new ones'. Second, they said that assigning tasks to create playlists would provide an opportunity to think about the attachments and meaning of the song. Finally, they said that qualitative data should be used as a standard for mapping the playlists with weight. They emphasized that the weight of the playlist should be categorized by emotion, the amount of accumulated experience rather than quantitative data such as the number of ‘like it’ or playbacks. Table 1 shows the comments of concept B.

Table 1 Comments of Concept B

Idea board	comments	
 Concept B – Tangible weight	Way to deliver the weight	• Analog rather than digital such as needle • Tangible weight • Weight scale
	Weighing standard	• Collection of empirical data • Psychological • Personal effort • Weight of effort that finding songs • Weight of pride Weight of reminiscence • Fellowship with favorite musicians

3.3 CONCEPT DEVELOPMENT

Feature

Research team regarded the metaphorical and effective way to utilize interactions and analog design elements (Figure 15-left) that play different weights based on tangible weight, we chose the concept B. We set the direction to connect the user with the digital contents using the tangible weight and to construct the playlist with the data based on the experience. We have developed a concept based on several features. First of all, the playlist with the Tangible weight did not give any difference in texture and shape. We designed a scenario that the user can focus on weight by applying only the difference in weight to three physical objects of the same shape and material. Instead, we provided a simple icon to help the user to recognize weight. Next, we use the analog scale metaphor to interact with tangible weight.

Concept

The design employs a metaphor of an analog scale that moves a needle in response to weight. The overall design was inspired by Dieter rams' portable radio (Figure 15) and developed for the table. The final design consisted of a vertically foldable cover and a rectangular body. The cubes of the playlist were made of wood, with small iron balls inside the same cube to give them a weight difference. Figure 16 shows our final concept sketch.

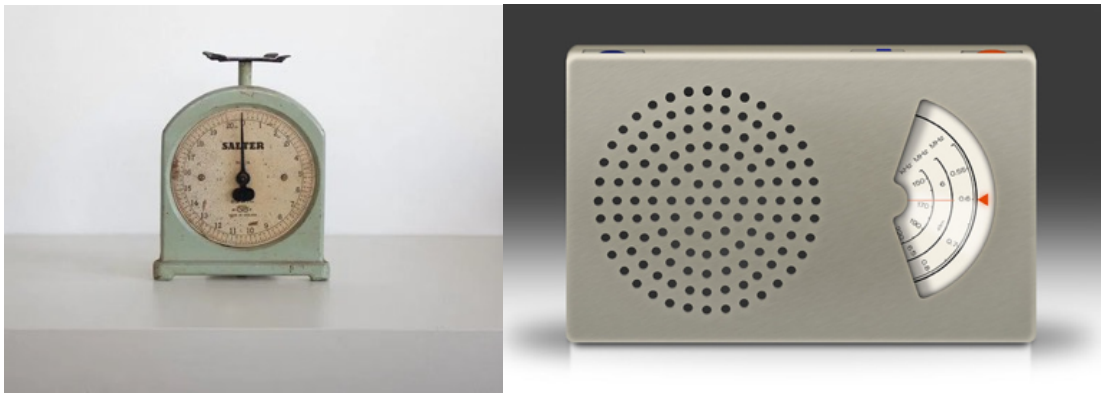


Figure 15 left - analog scale, right – T 41 radio (Rams, 1962)

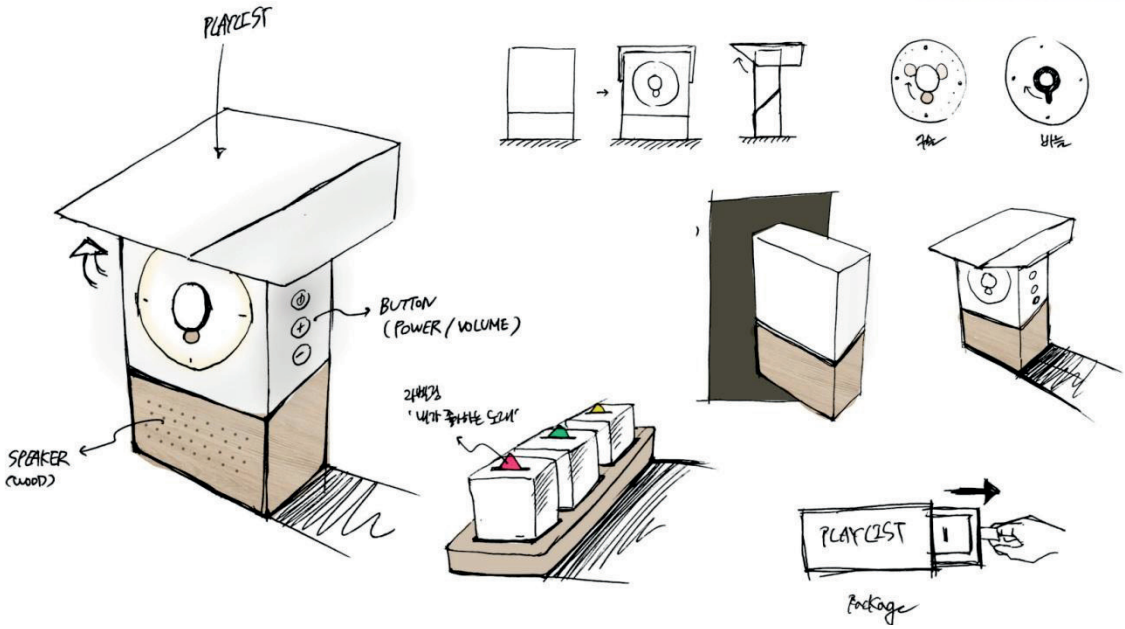


Figure 16 Final idea sketch of our concept

Interaction

Interview with the user and put the grouped playlist on the memory card. And We provide the tag to each weight of the cube. The music data classified memory storage. And read each tag of the cube(playlist), the player playback according to the read tag. Folding the cover vertically provides space to raise it. If you put the cube on it, it recognizes the tag for each weight and plays the song you matched. The needle moves to the position according to its weight to help convey information.

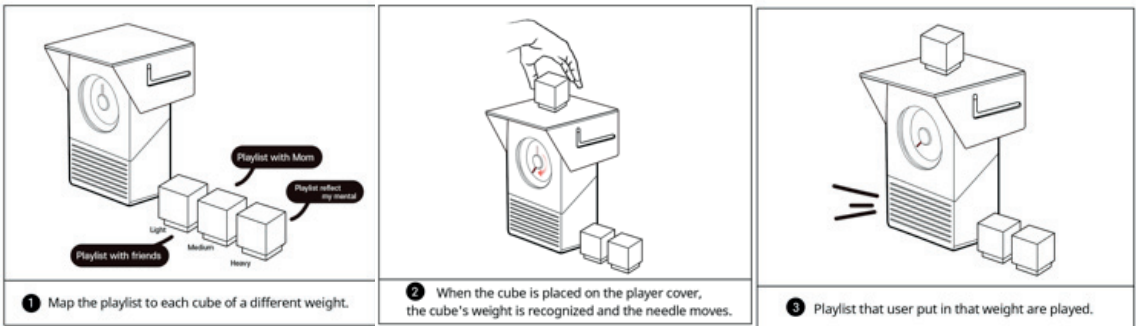


Figure 17 Interaction of MuScale

3.4 IMPLEMENTATION

Mechanical implementation

MuScale consists of a folding cover, body, speakers and three cubes. When the cube is placed on the upper part of the body by the RFID reader, the tag sticker on the bottom of the cube can be recognized. Import information of the recognized tag and play a file for each tag of the cube. The tag is recognized, the needle rotates to 270 degrees depending on the angle of the motor and moves to the correct position for the weight. A servo and two gears were used to implement the interaction of the needle on the analog scale. The playlist consists of three wooden cubes of the same appearance. There is a tag sticker on the bottom of the cube. Figure 18 shows the structure of MuScale.

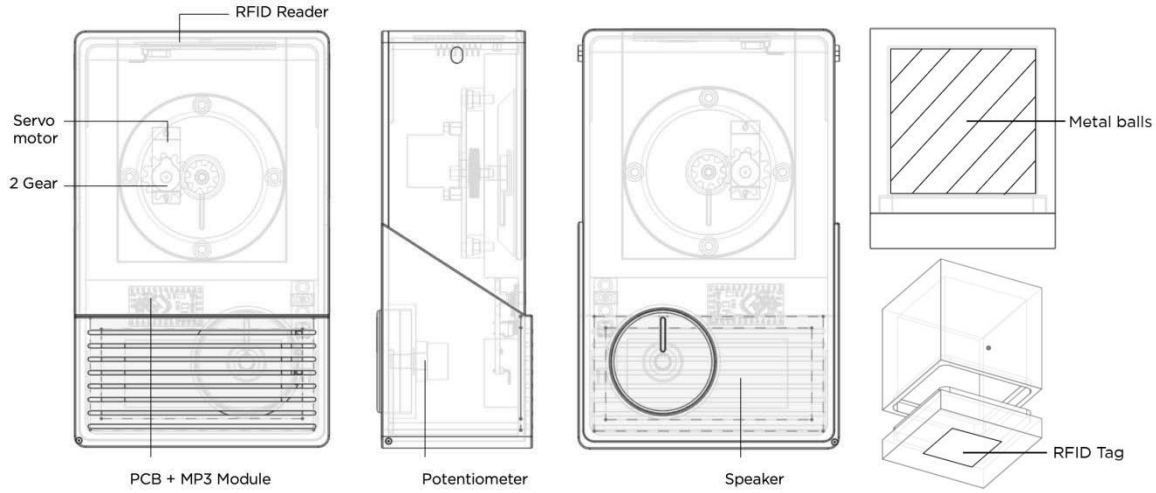


Figure 18 Structure of MuScale

Prototyping

To create MuScale, we used various materials. The body of the player is made of plastic and the cover is made of translucent plastic. Inside the body, we have placed the PCB board and the components for operation. In the case of playlist cube, we used wood. We put a metal ball into a wooden cube that had been emptied inside, give a difference of weight. The cubes weighed each 30g, 110g, and 200g. To help weight recognition, a hexagon icon is engraved on top of the cube. The number of hexagons indicates the difference in weight.

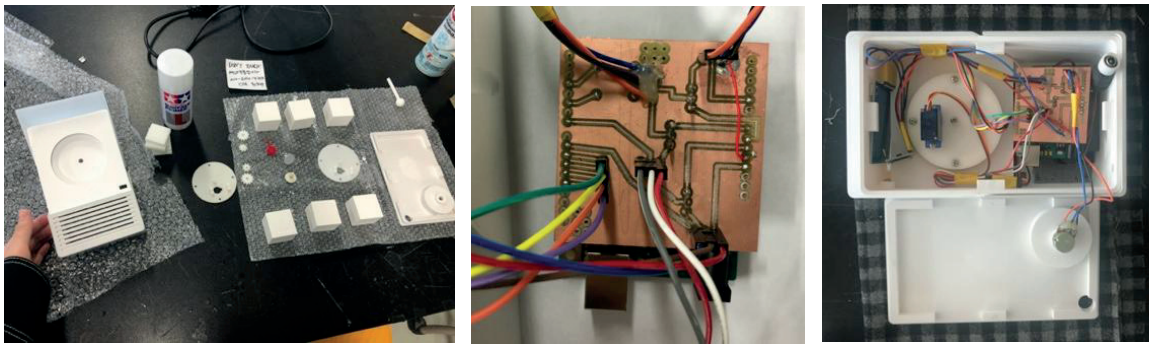


Figure 19 Prototyping

3.5 USER STUDY

We conducted a two weeks field study to explore what value and experience MuScale offer when playing a playlist that reflects its weight in actual use. Figure 20 shows the structure of the user study.

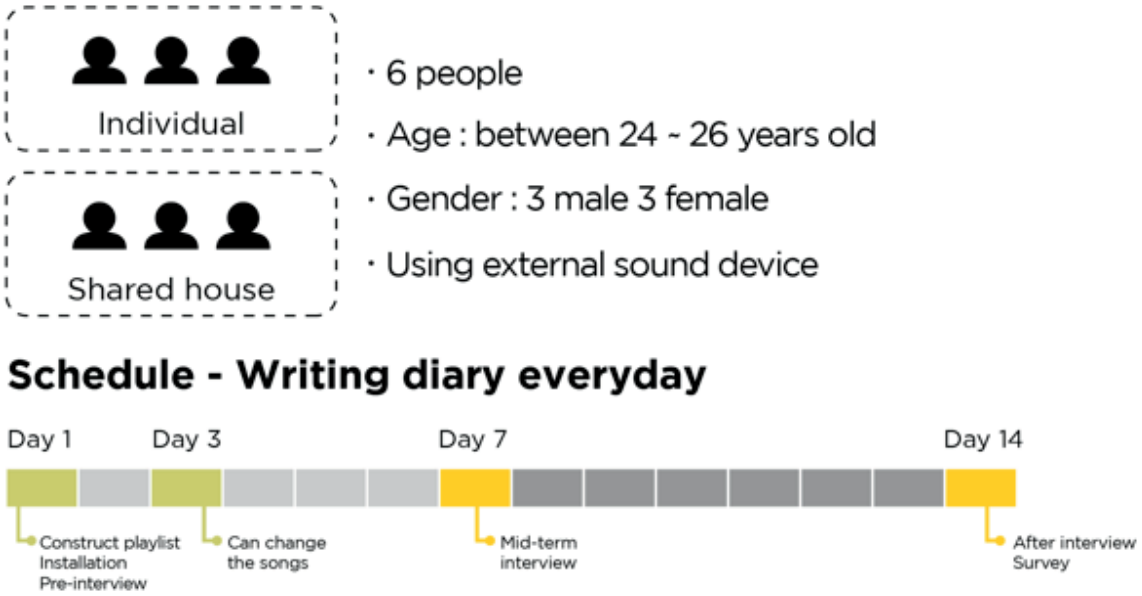


Figure 20 Structure of user study

Participants

We recruited six participants for those who were used to using external music devices such as Bluetooth speakers in personal space. Participants consist of three males and three females who have various fields such as chemistry, design and mechanical engineering. All of the participants were listening to music through streaming service and external speakers at their home. We worked on an interview with a weighted playlist before the field study. Table 2 shows the ages and household types of each of the 6 participants and how they matched the weights on the playlist.

Table 2 age, household type, basis of categorizing of each participant

ID	Age / gender	Household type	Standards of categorization
P1	25 / Male	Shared (Girlfriend)	Genre, tempo
P2	23 / Female	Individual	Mood
P3	23 / Female	Individual	Mood
P4	25 / Female	Individual	Mood
P5	24 / Male	Shared (Girlfriend)	Psychological state
P6	24 / Male	Shared (Friends)	Psychological state

Materials

Field study

We provide a MuScale to the participants (Figure 21). MuScale was installed in the participants' house for two weeks. Users installed and used where they wanted in their homes. Before delivery, we asked participants to draw or write a playlist group directly on the transparent acrylic on the dashboard.

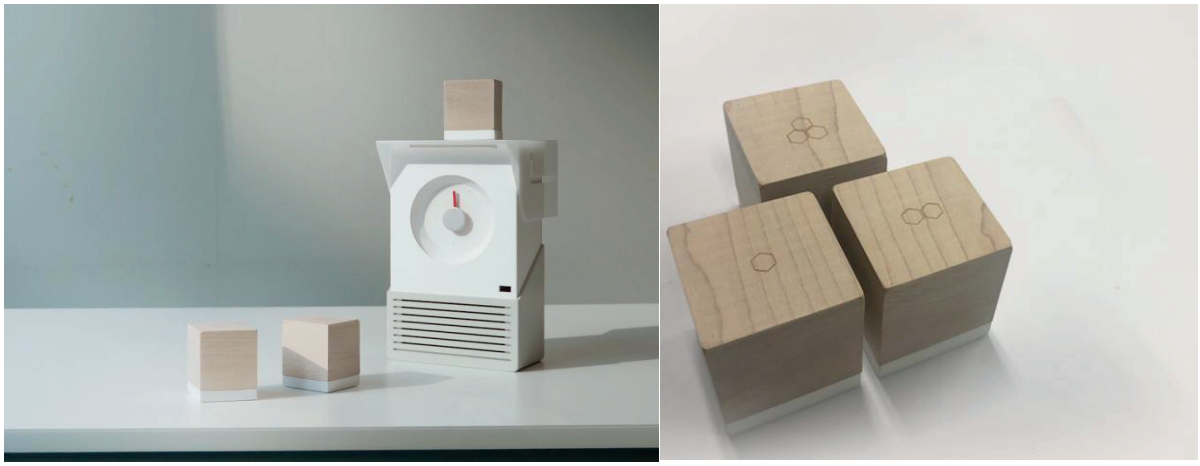


Figure 21 MuScale

Interviews

While user study, we conducted three times of interviews. The first interview is to explore what they connect music with weight. In the second interview, we request to describe the overall usage context for seven days and asked the change perception or behavior of music. After 14 days, we finished the user study and conducted an after interview. We asked the experience and feeling through interact between weight with music data. Table 3 shows a summary of the interview contents.

Table 3 Summary of Interview contents during the user study

Interview day	Interview contents
Introduction day	• Meaning of favorite songs • Standard of weight
Mid-term (7^{th})	• Overall usage context for seven days • Change perception and behavior
After interview (14^{th})	• Overall usage context • Listening experience while compared to other music devices • Meaning of weight in music • Interaction between weight with music data

Diary study

We delivered a paper diary to all participants. We asked in the form of pictures and notes for reminders at the interview. We asked participants to write every day. Flaherty suggested diary as a research method for qualitative data collection of user behaviors and experiences. She explained that four categories can help to understand long-term behavior (Flaherty, 2016). Questions organized into those four categories. The diary consists of (a) Habits, (b)Usage scenario, (c) Motivation, and after seventh day and 14th day of use, (d)Change perception or behavior items were added to the idea or behavior of the song after continuous use (Table 4).

Table 4 Questionnaire of diary

Category	Question
a. Habits	• When did you use the product during the day? • How did you use it?
b. Use scenario	• What did you use it for? • Describe the scene using the product.
c. Motivation	• If you were motivated to use this product during the day, what is it? (trigger) • What did you feel from weight in the process?
d. Change perception or behavior	• Did you change your mind about the songs? if changed, why did it change? • After playing, has anything changed? (think, meaning, situation)

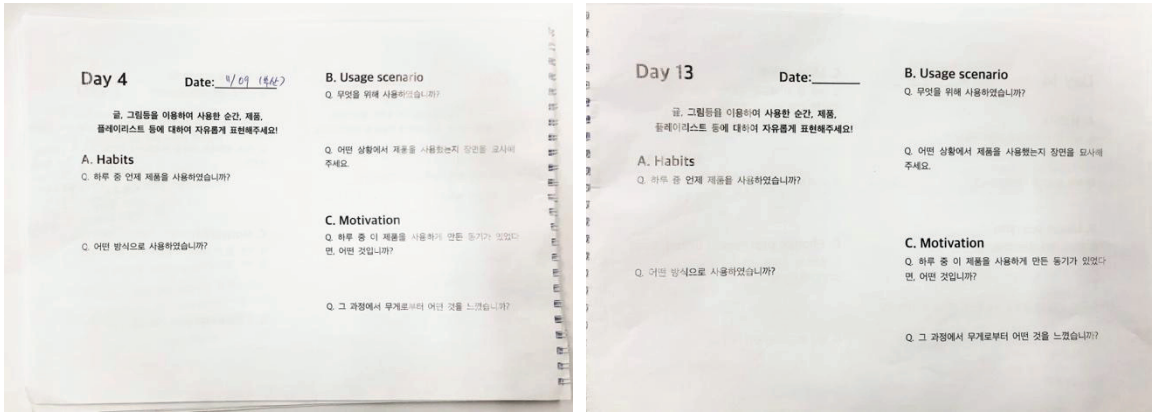


Figure 22 Diary

Survey

At the end of the experiment, the survey was conducted based on the measurement model of Danckwerts. This model was used as a means to measure Pierce's three factors on the Likert scale for psychological ownership of streaming service platforms. Participants responded to the question in five levels, from one (strongly disagree) to five (strongly agree). We divided the sections for streaming and MuScale to compare the devices and platforms that provide music and restructured the question from Danckwerts (Danckwerts & Kenning, n.d.) to conduct a survey. Table 5 shows the questions of the survey, provided through On-line platform.

Table 5 Survey questionnaire

Streaming service	• I feel the library of this streaming service is my personal possession. • For enjoying music service, I usually invested a lot of things and enjoy making myself.	
About MuScale	Product	• Context of use • I feel the playlist of this music cube is my personal possession. • Which weight of playlist did you feel most emotionally attached to? • What did you like the best feature of the MuScale?
	Investment of self	• I feel the playlist of this music cube is my personal possession. • I invested parts of myself in the music cube. • While making this playlist, I reflected about me and felt interesting. • This cube expressed my identity and taste.
	Intimate Knowledge	• I feel familiar with this playlist. • I know the knowledge of the songs in this playlist. (Information of artists, songs…) • I understand the feature of this music cube. And I organized the playlist to reflect them.
	Control the object	• I organized the playlist as I wanted. • "Tangible playlist" influenced the organization of playlists. • Actual weight influenced the organization of playlists. • Through this product, I could always play music that matched my mood. • I am satisfied, despite the inconvenience from product.

Procedure

A week before installation, participants asked for their 15 favorite songs based on the streaming playlist. Each participant submitted a playlist based on their memory and taste. Before installation, we interviewed why the song was chosen and what it means. Afterward, the participants were classified into playlists based on weight, regardless of the number of songs. We delivered the product and requested participants to record the diary (Flaherty, 2016; Tomitsch, Singh, & Javadian, 2010). MuScale was installed in the participants' house (Figure 23). On the third day, we gave them the opportunity to change or add the song. On the seventh day, we conducted a mid-term interview. On the 14th day, we conducted an after-interview with the survey (Figure 24). The survey was conducted based on the measurement model of Danckwerts & Kenning (Danckwerts & Kenning, n.d.).

Figure 23 Installation of MuScale

Figure 24 After interview with survey (P4, P5)

3.6 DATA ANALYSIS

We transcribed 467 minutes of interview recordings. The result of the survey was analyzed according to the response frequency and qualitative analysis was conducted along with the interview data. We categorized and analyzed interview data and diary data (Figure 25) using affinity-diagrams. The interviews were categorized into 10 groups according to the participants' responses. The interviews were classified into two main topics.

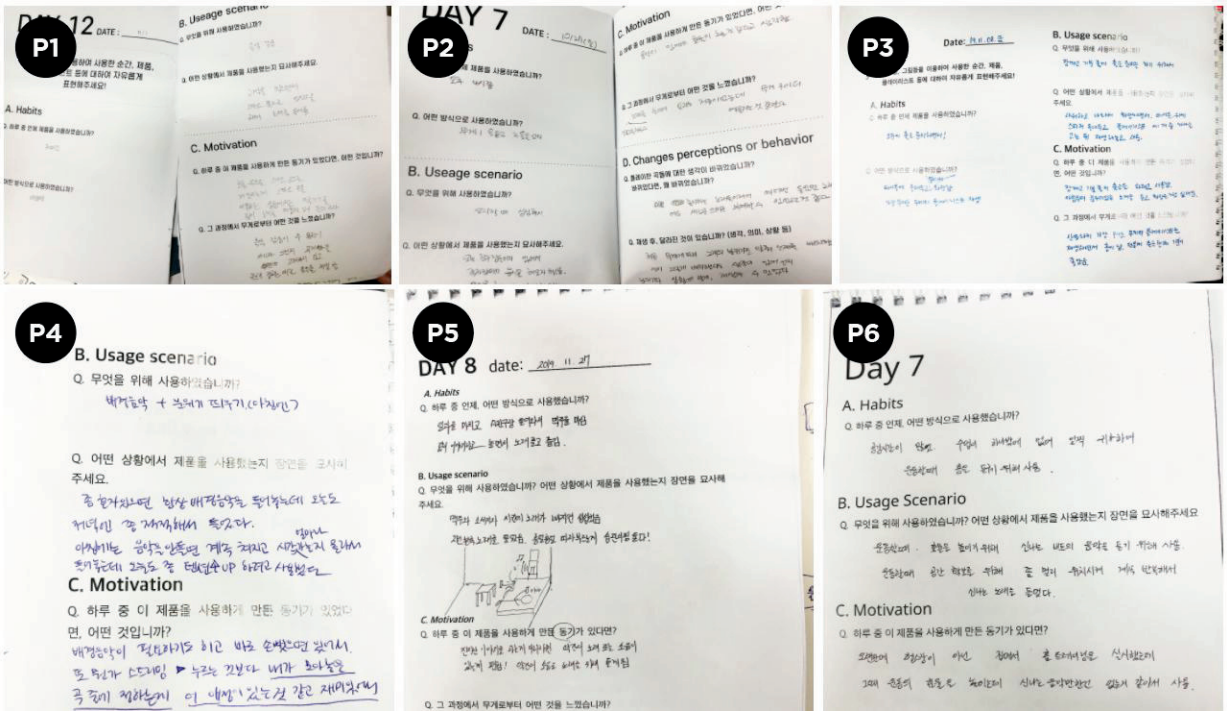


Figure 25 Diary written by participants

Chapter 4

Results

We categorized and analyzed data using affinity-diagrams. Figure 26 shows the data classified through affinity diagram as keywords and classified according to the usage process.

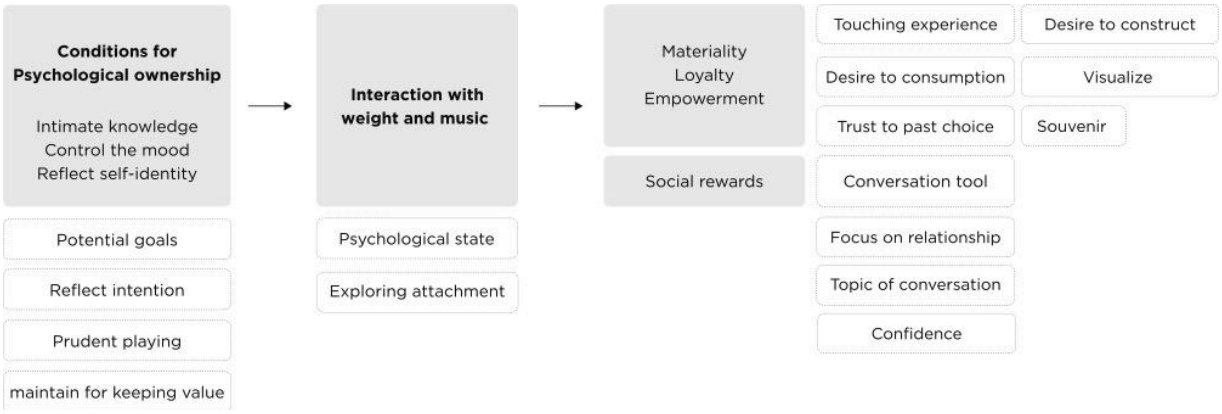


Figure 26 Keyword of affinity diagrams

4.1 RELATIONSHIP BETWEEN PSYCHOLOGICAL OWNERSHIP WITH TANGIBLE WEIGHT

Based on the survey, which reconstructed the measurement model of Danckwerts (Danckwerts & Kenning, n.d.), interviews measured the state of psychological ownership in the process of constructing tangible playlists and experiencing. First, participants showed various perceptions of streaming music services. Two of the six participants said they didn't feel like personal possession, according to P5, *"I want to control or touch it, but it was not… For example… In the case of Youtube, block it from creator or service, I can't do anything. I think it's driven by money and network. Also, I don't even categorize the playlist…"* Three participants responded that they felt the personal possession of streaming music. P4 mentioned *"Streaming service played automatically when I am listening to music with someone… I feel exposed to my mood. I can express it to someone close to me. But to the stranger, a little bit shy (laughing)."*

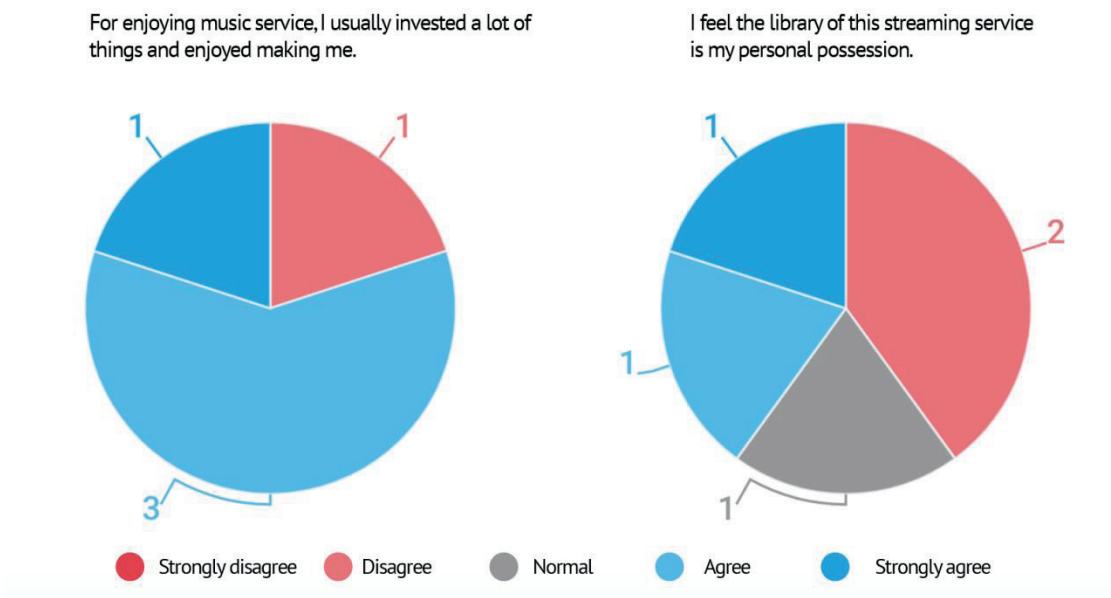


Figure 27 Result of streaming music

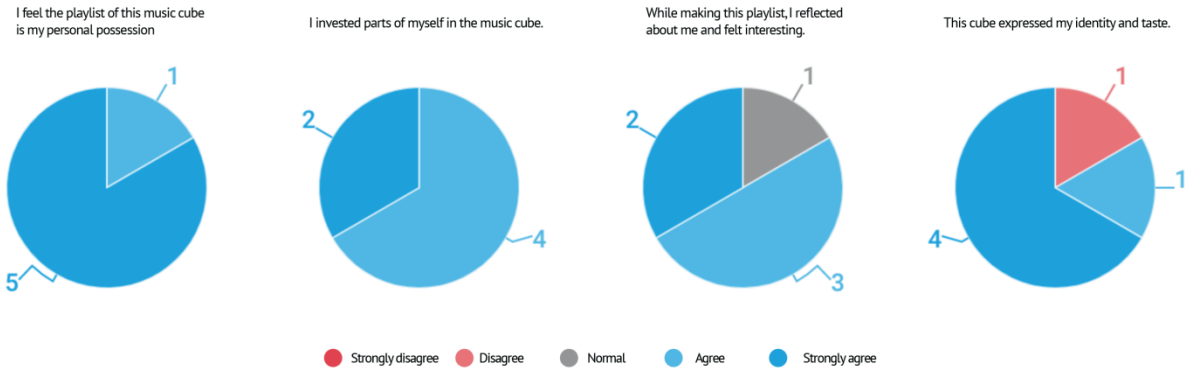


Figure 28 Result of survey question about 'Investment of self-identity'

Five of the six participants highly agree that they ‘invested parts of myself’ and ‘that process sere interested’. Five participants agreed that they mapped the weights based on songs they knew some information of each song (Figure 29). P1 mentioned, “If I like the song, I find it naturally... Get information on Facebook. Searching Youtube and watching all of the concert video.” All participants agreed that ‘by playing a playlist based on weight, I could play the music that matched my mood.’ In particular, five of the participants said they were most satisfied with the experience of easily changing the atmosphere according to each weight (Figure 30).

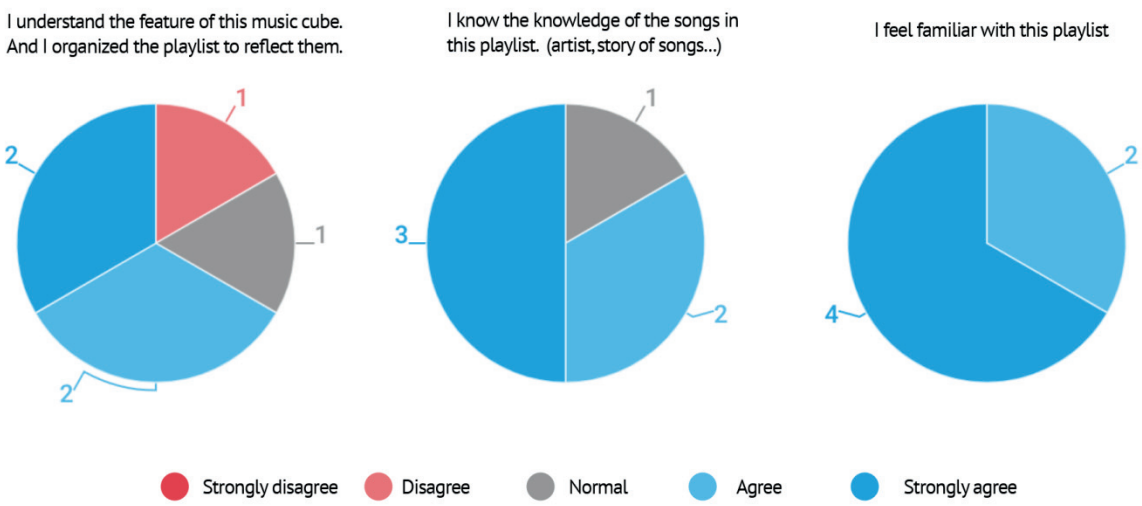


Figure 29 Result of survey question about 'intimate knowledge'

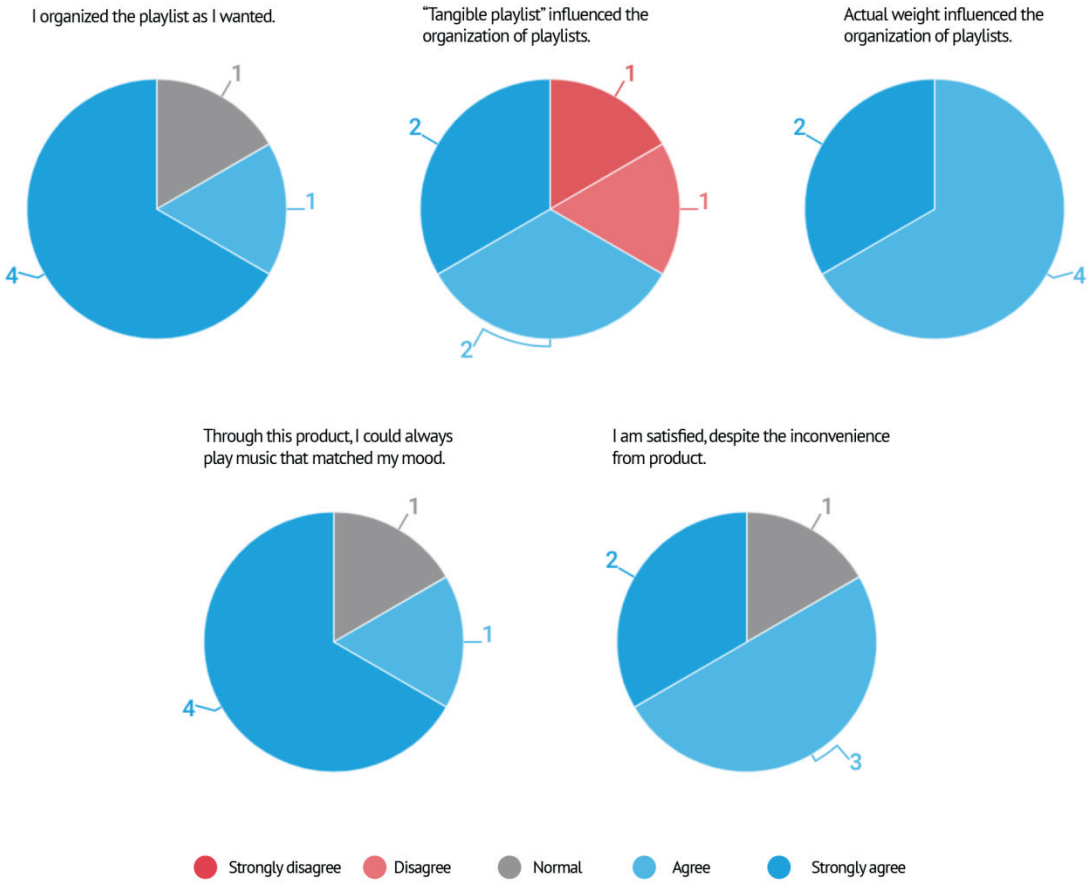


Figure 30 Result of survey question about 'control the mood'

Five participants talked about their experiences with one or more people, regardless of the household type, during the period of the experiment. In response, P4 said, *"Before I told you that I couldn't feel anything... Because I was alone at that time. But I listened to it with my boyfriend. It was... Exactly something different rather than when I heard it alone…"* In particular, five participants were positive about their experiences of sharing the playlist and talking and expecting to share with more people in more social places. P5 mentioned, *"Camping. Camping usually goes with people who are deep relationships. I think it's nice to save songs about relationships. Find a smartphone, unlocking the phone… Turn on and application… searching the songs in my messy playlist… Instead of a complicated. I don't want to be bothered by that time. But it will be… we can concentrate on our time."* And he hoped that the focused listening experience provided by tangible data. Besides, they tended to share the weight of their neighbor's playlists and their stories. Among them, according to P2 and P4, *"How are they… there are various genres, and I wonder how their moods differ by weight. (P2)"*, *"Table? Dining Table with family. Something… In a place where many people gather. I think each playlist is different by weight. (P4)"*

4.2 EXPERIENCE THROUGH INTERACTION BETWEEN MUSIC WITH TANGIBLE WEIGHT

MuScale's experience with weight has emerged in three stages: song matching – weight and listening experience – value derivation. We classified the results from each stage into two groups. We identified what they are meaning reflected in weight during the selection process and the experience from the process that choosing the weight.

Meaning reflected in weight during the selection process

Participants stored songs that fit each weight (Table 6). Five participants were weighted according to their psychological state. They all matched the joyful, fast beats of music to the 'lightweight' cube. In the case of the 'heavyweight', they reflected seriousness and recalled personal memories. P3 mentioned, *"Calm songs. I actually touched this cube… I want to use it seriously rather than just heavy."* On the other hand, 'medium weight' cubes were matched by various groups other than psychological states. It is divided into a song that recalls memories with a specific person (P4, P5) and a song that improves their mood (P1, P2, P3, P6). Among them, P4 mentioned, *"It contains my memories. But it feels and not too heavy. Mainly on relaxed and convenient…"*

Table 6 Each playlist of participants

ID	Light	Medium	Heavy
P1	For fun, joyful Fast beat	Love song. Relaxing Between fast and slow	Slow beat R&B
P2	Playlist for preparing.	Ordinary feeling.	Favorite songs but, I listen to sometimes
P3	Motivation, For exercise	Favorite songs. Makes me feel good. Rainy day	A calm song. Use with a serious state
P4	For fun, joyful	Enjoyable memory Memory with boyfriend, Rainy day, Relaxing, Calm	Calm Reminiscent of past time Weight of love for my kitten
P5	Morning Fast beat, encourage	Related with girlfriend. Daily life with her	Before go to bed A song that end of the day
P6	Joyful, exercise	Between fast and slow	R&B Personal memory. Serious state

Experience from choosing weight

Five participants responded that they thought about each weight and their intentions and played the cube when they choose. Participants tended to think in connection with the linguistic meaning of 'light' and 'heavy'. All participants used the light cubes to joyful and bright music for the active atmosphere. On the other and, heavy cubes were used at serious moments that required mind control (P3, P5), mentioned P3, *"I put in the heaviest things... and it slows down my behavior. I mean…Consolation or Healing by weight? Heaviness tells me, "It's okay to take a rest." I think it says."*

Besides, half of the participants mapped songs containing memories that had been accumulated over a long period in a heavy cube. They said, *"Because, I like this song for a long time, but I don't feel bored easily… I don't feel tired even if I listen to it steadily. But I didn't try to listen much. (P2)", "It was already worn out, so I don't like to listen… But my affection was the highest. (P6)"*. Through this, the participants mapped the most personal experiences to the heavyweight, but the frequency of music playback was not high because they were concerned about the deterioration of attachment of the playlist. In particular, the seriousness of the attitude to the song tends to be proportional to the weight.

In particular, the interface reminiscent of the needle of the scale reminded 4 of 6 people to reminisce the analog experience. According to P4, *"A needle indicating the weight…I thought that MuScale like an adjusts radiofrequency. It's been a long time since I heard a song without a display."*, Two of them felt it helped them to recognize that the needle was working properly. According to P5, *"I feel directly. Even if it doesn't work, I thought that 'The needle doesn't move. Why is this doesn't work? ' But I can't do anything with this (smartphone). Is there a network error? or my phone strange? It only gives feedback through the screen."* On the other hand, two out of six said they focused more on feeling the weight of the cube than on the needle and interface design. Among them, the P6 said, *"Just... I felt tangible weight with the cube. The needle didn't do something."*

Chapter 5
Discussion

MuScale has introduced a way to sustain the value of digital music through the concept of 'psychological ownership' of digital content. Giving weight of tangibility to intangible digital music provided an opportunity for users to engage actively in the process of organizing playlists and to think about semantic values.

5.1 EXPERIENCE PSYCHOLOGICAL OWNERSHIP THROUGH TANGIBLE WEIGHT

The tangible playlist, which reflects the meaning of the tangible playlists with three different weights has been shown to satisfied the three stages of psychological ownership(Pierce et al., 2003), from the construction process to the experience. In the process of turning intangible digital data into tangible, participants reflect their identity by classifying his favorite songs based on their experience and lifestyle (e.g. weather, person, situation) accumulated in the songs (Intimate knowledge), and then, they could play a specific playlist for the feelings their situation and change their mood. (control the environment) From these phases, the primary needs for appearing psychological ownership were satisfied (Pierce et al., 2003). Then, they expressed psychological ownership through weight segmentation: Establishment of self-identity through modification of playlist, efforts to maintain listening context and value, and sharing. Subsequently, All four aspects of psychological ownership in the music experience described by Sinclair and Tinson (Sinclair & Tinson, 2017) appeared evenly, which will discuss with the experience of interaction with weight.

5.2 FACILITATED OPPORTUNITY TO SELF-REFLECTION THROUGH TANGIBLE WEIGHT

The physical properties felt from the tangible weight induced the desire for convenience and additional creation (Materiality - Originality given by real objects. Importance of material possessions). Reliable choice based on past choices, along with intuitive interaction led to more continuous use (Loyalty - Comes from the familiarity of interface or music). The tactile experience provided with choosing different three tangible weight to control the mood while giving the opportunity to directly think about the relationship between weight and song (Empowerment – comes from controlling environment and mood). In particular, the materialized digital contents, which physically separated from the digital world, provide a concentrated experience free from the stimulus of other media (e.g. messages or alarms from other applications in the smartphone) and provides a

relaxing environment that helps the user to get mindfulness.

In these processes, we could confirm that users organized their playlists with potential goals (e.g., exercise is a light cube, mindfulness is a heavy cube) by different tangible weights and then remind goals through listening. We could confirm that some participants modified their playlists and they wanted to complete the content they wanted through weight segmentation (P1, P4, P5). On the other hand, some participants noticed that at each stage of weight they projected potential goals and adjusted the mood through each weight only in the right context, playing carefully to keep their potential goals and values projected according to their weight (P2, P3, P5). We have identified the possibility that the experience of combining digital music with three levels of weight can be a means of reflection (Li, Dey, & Forlizzi, 2011) that reminds them of their tastes and their purpose for listening.

Thus, we could observe that reflecting potential goals to gradual weight can lead to reflections that allow one to realize intentions in the process of consuming content, thereby identifying the improved ownership of digital content.

5.3 WEIGHT EXPERIENCE AS A CONVERSATION TOOL

Interestingly, MuScale could figure out that used as a means of communication tool with friends of participants. This phenomenon related to the aspect of social rewards in psychological ownership. Specifically, it follows three phases: the first is used as a method for conversation, the second is that it was a positive experience, and the third phase is to use the weight to expand the conversation through more sharing.

Figure 31 Three phases of sharing experience

The value that comes from sharing their playlists with others goes beyond the confident and achievement to explain the role of music at the social level. Along with the previous study (Lenz, Diefenbach, Hassenzahl, & Lienhard, 2012) experiences throughout the listening process through the phases of materiality have evolved into very intimate behaviors with psychological meanings along with the expression of one's personality. The digital content that has been put first in the process of adding meaning to the material properties gives a strong impression and trust to the user. We could conclude that the playlist with tangible weight arouses curiosity and conversation about each other's playlist and that it facilitated provides a desire to share digital content in a social context and give a strong impression and trust (e.g., intimacy, concentrate) to a partner.

5.4 DESIGN IMPLICATION

In the design community, including the field of HCI we are looking for ways to sustain the value of the digital content and convergence of the current technology and old technology. Through our findings from MuScale, we could suggest the implication that can raise a sense of ownership in the value of intangible digital content beyond music. The major contribution of this study is summarized as follows.

First, applying gradual physical properties to the grouping of playlists can be a new way of organizing playlists in streaming services that provide emotional music streaming brand experiences beyond providing digital content. Odom argues that the emotional attachment to technology extends its life and the need for interactions that can continue to share emotions for generations (Odom, Banks, Durrant, Kirk, & Pierce, 2012; Odom, Sellen, et al., 2012). MuScale proposed the requirements of the categorization that can effectively contain self-identity through tangible weight. In addition, participants in this study were given their own time and atmosphere, free from the stimulus of the media, despite the inconvenience of technical limitations and closed mobility of the content. Physically separating and managing digital content can increase satisfaction and emotional attachment to music. Through the materialization of digital content, users actively use the content according to their tastes and intentions. This enables service designers and planners to discover new needs and services from digital content that satisfies psychological ownership.

Second, in this context, if utilize the gradual empirical data mapping with music streaming service that using voice commands, data technology can be expected to bring closer to the user's experience, helping to improve intimacy AI and reliability of the service. Such an experience-driven content organization is likely to be adopted as one of the service delivery methods. In media clouds, user can collect and structure of gradual information about the content they want from time to time. It can be used in data technologies, including the analog values described above.

5.5 LIMITATION AND FUTURE WORK

The purpose of applying the metaphor of analog scales was to interact with the user. However, it was only a secondary means to create the instrument board on the scale and move the needle. In the future work, we will expand the role of the needle, improving the greater role in the interaction with a weight such as indicating playback time or the amount of data. We could find that we needed to expand the visual experience through improving interface quality, reminiscent of analog balances, by slowing the needle speed.

Besides, in the design of experiments, we will induce the participation of housemates (e.g., family, marriage partner, friends) in the shared context of household types. In the course of the experiment, one participant was focused, but if the housemate or family participate in all processes of the selection, use, and interview, we will discover another insight.

Chapter 5
Conclusion

The dematerialization trend of entertainment along with the development of technology has brought about the boredom and dehumanization of the listening experience. We conducted a study to recover emotional attachment and valuable listening experience through physical properties. For this study, we derived the concept of MuScale through interviews and focus group interviews. We applied metaphorical interaction of analog scale and provide a task for construct playlist through tangible weight to the user and observed the relationship between digital music and user. As a result, people reflected in three different weights that their potential goals and tastes that accumulated for a long time. In the process of constructing the playlist by reflecting the weight, qualification for the psychological ownership was satisfied, and the appeared 'self-reflection' through the aspect of psychological ownership in the music experience. Materialized playlist aroused the desire to complete a perfect playlist or additional consumption. On the other hand, participants have prudently consumed to maintain the value that can be felt from potential goals and their intentions. The weight combined with linguistic meaning and aroused participant's self-reflection. Furthermore, we could find out the MuScale has evolved into a new way of conversation. In social relations, the standard of weight and the experience reflected in it became the subject of conversation and facilitated relation improvement. Our findings can be proposed as a new consideration when designing services for segmenting playlists, improving attachment through self-reflection, and social sharing on the music platform of the future. And through this study, we provided designers with the possibility and opportunity to materialized their tastes and lifestyles in a sharing context.

REFERENCES

1. Bartmanski, D., & Woodward, I. (2015). The vinyl: The analogue medium in the age of digital reproduction. Journal of Consumer Culture, 15(1), 3–27.
2. Belk, R. W. (2013). Extended self in a digital world. Journal of Consumer Research, 40(3), 477–500.
3. Brown, B., & Sellen, A. (2006). Sharing and listening to music. In Consuming music together (pp. 37–56). Springer.
4. Danckwerts, S., & Kenning, P. (n.d.). "It's MY Service, it's MY Music": The role of psychological ownership in music streaming consumption. Psychology & Marketing.
5. Flaherty, K. (2016). Diary studies: Understanding long-term user behavior and experiences. Nielsen Norman Group Articles, June, 5, 2016.
6. Giaccardi, E., & Karana, E. (2015). Foundations of materials experience: An approach for HCI. In Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems (pp. 2447–2456). ACM.
7. Hornecker, E. (2011). The role of physicality in tangible and embodied interactions. Interactions, 18(2), 19–23.
8. Jansen, Y., & Dragicevic, P. (2013). An interaction model for visualizations beyond the desktop. IEEE Transactions on Visualization and Computer Graphics, 19(12), 2396–2405.
9. Jenkins, T. (2018). Cohousing IoT: Design Prototyping for Community Life. In Proceedings of the Twelfth International Conference on Tangible, Embedded, and Embodied Interaction (pp. 667–673). ACM.
10. Jussila, I., Tarkiainen, A., Sarstedt, M., & Hair, J. F. (2015). Individual psychological ownership: Concepts, evidence, and implications for research in marketing. Journal of Marketing Theory and Practice, 23(2), 121–139.
11. Kallinen, K., & Ravaja, N. (2004). The role of personality in emotional responses to music: Verbal, electrocortical and cardiovascular measures. Journal of New Music Research, 33(4), 399–409.
12. Kim, K. J., Jang, S., Kim, B., Kwon, H., & Park, Y.-W. (2019). muRedder: Shredding Speaker for Ephemeral Musical Experience. In Proceedings of the 2019 on Designing Interactive Systems Conference (pp. 127–134). ACM.
13. Lenz, E., Diefenbach, S., Hassenzahl, M., & Lienhard, S. (2012). Mo. Shared music, shared moment. In Proceedings of the 7th Nordic Conference on Human-Computer Interaction: Making Sense Through Design (pp. 736–741). ACM.
14. Li, I., Dey, A. K., & Forlizzi, J. (2011). Understanding my data, myself: supporting self-reflection with ubicomp technologies. In Proceedings of the 13th international conference on

Ubiquitous computing (pp. 405–414). ACM.

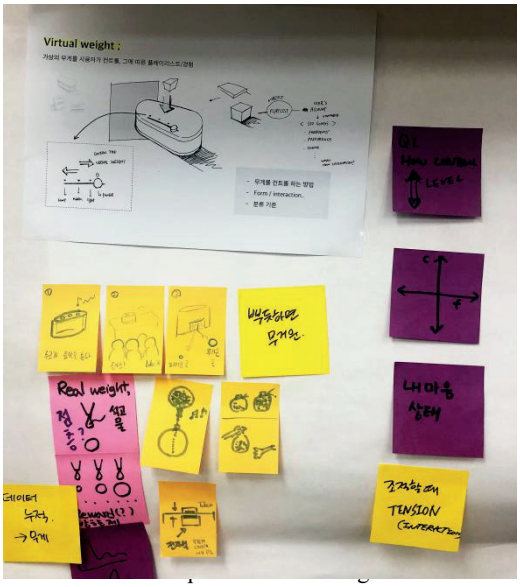
15. Magaudda, P. (2011). When materiality 'bites back': Digital music consumption practices in the age of dematerialization. Journal of Consumer Culture, 11(1), 15–36.
16. Moere, A. Vande. (2008). Beyond the tyranny of the pixel: Exploring the physicality of information visualization. In 2008 12th International Conference Information Visualisation (pp. 469–474). IEEE.
17. Morris, J. W., & Powers, D. (2015). Control, curation and musical experience in streaming music services. Creative Industries Journal, 8(2), 106–122.
18. Odom, W., Banks, R., Durrant, A., Kirk, D., & Pierce, J. (2012). Slow technology: critical reflection and future directions. In Proceedings of the Designing Interactive Systems Conference (pp. 816–817). ACM.
19. Odom, W., Sellen, A., Harper, R., & Thereska, E. (2012). Lost in translation: understanding the possession of digital things in the cloud. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 781–790). ACM.
20. Ozengestudio. Qleek (2014).
21. Parra, J. Spotify box (2011).
22. Pierce, J. L., Kostova, T., & Dirks, K. T. (2003). The state of psychological ownership: Integrating and extending a century of research. Review of General Psychology, 7(1), 84–107.
23. Pink, S., Ardèvol, E., & Lanzeni, D. (2016). Digital materialities: Design and anthropology. Bloomsbury Publishing.
24. Scheel, K. R., & Westefeld, J. S. (1999). Heavy metal music and adolescent suicidality: An empirical investigation. Adolescence, 34(134), 253–274.
25. Sinclair, G., & Tinson, J. (2017). Psychological ownership and music streaming consumption. Journal of Business Research, 71, 1–9.
26. Skågeby, J. (2011). Slow and fast music media: comparing values of cassettes and playlists. Transformations (14443775), (20).
27. Tomitsch, M., Singh, N., & Javadian, G. (2010). Using diaries for evaluating interactive products: the relevance of form and context. In Proceedings of the 22nd Conference of the Computer-Human Interaction Special Interest Group of Australia on Computer-Human Interaction (pp. 204–207). ACM.
28. Watkins, R. D., Denegri-Knott, J., & Molesworth, M. (2016). The relationship between ownership and possession: observations from the context of digital virtual goods. Journal of Marketing Management, 32(1–2), 44–70.

APPENDICES

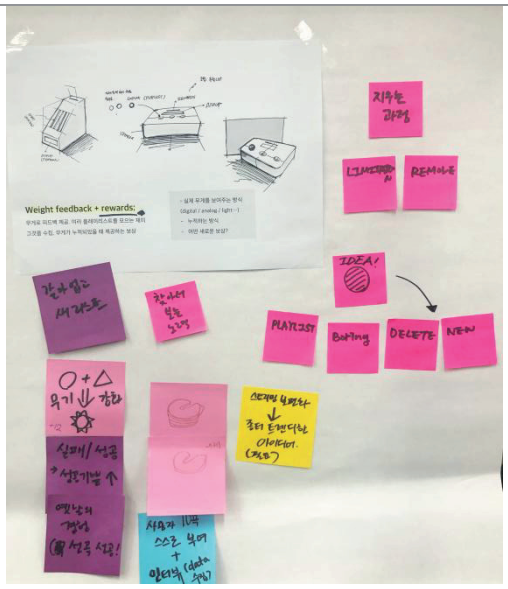
Appendix A Response frequency of preliminary study

	Question	Response	Frequency(n=20)	Percentage (%)
Light	Object (Associated Target)	friends	13	65
		Family	2	10
		Hobby	2	10
		Inside of me	2	10
		Lover	1	5
	Listening context	Brighten up mood (fun)	12	60
		Reminiscence	6	30
		Working	2	10
Medium	Object (Associated Target)	Lover	8	40
		Friends (include colleagues)	7	35
		Inside of me	3	15
		Family	2	10
	Listening context	Reminiscence	11	55
		Sharing flavor with each other	5	25
		Relaxation (refresh)	4	20
Heavy	Object (Associated Target)	Personality (inside of me)	9	45
		My flavor	5	25
		Lover	3	15
		Friends	2	10
		Family	1	5
	Listening context	Encourage my self	7	35
		Reminiscence	6	30
		Relaxation (refresh)	5	25
		Hobby	2	10
Basis of weight	Accumulated experience	mental state	3	40
		Term of lifestyle	2	
		Music habit formation	2	
	Relationship	Tension of relationship	4	30
		Physical distance	1	
		Recommended person	1	
	feelings		4	20
	Scarcity value		2	10

Appendix B Summary of concept A

Idea board	comments	
	Way to deliver the weight	• Weight on button when adjusting • Electromagnet • Weight depends on people's reaction (Social context) • Physically accumulation depends on frequency of playback
	Weighing standard	• My psychological state • When feel confidence, heavy weight • Frequency of playback

Appendix C Summary of concept C

Idea board	comments	
	Way to deliver the weight	• Consideration of the 'between deleting and making new playlist'
	Weighing standard	• Provide Random list through combine playlists • Success and fail • Unexpected pleasure that finding new playlist

EXECUTIVE SUMMARY IN KOREAN

MuScale: 개인 디지털 음악 데이터와 물리적 무게에 대한 경험 연구

기술의 발전에 따른 엔터테인먼트의 비물질화 트렌드에 따라, 음악의 일상화와 동시에 청취 경험의 화면에 갇힌 지루함, 비인간화를 불러왔습니다. 우리는 옛날의 것들에서 느꼈던 감정적인 애착과 그것을 관리하고 뿌듯함을 느끼는 '심리적 소유권' 을 회복하기 위한 연구를 진행했습니다. 실험을 설계하기 위해 우리는 먼저 20명을 대상으로 무게를 음악과 연결 짓는 경향에 대해 조사하였습니다. 인터뷰 참여자들은 기억 회상의 대상, 나 자신에 대한 이야기를 기준으로 무게와 연결 지었습니다. 그 후, 무게와 사용자 사이의 상호작용 방법에 대해 3개의 아이디어를 도출하고, 포커스 그룹 인터뷰를 통해 최종 아이디어를 선별하였습니다. 이러한 선행 연구를 바탕으로, 우리는 무게와 저울의 메타포를 적용하여 디지털 뮤직과 사용자 사이의 관계를 탐구하고자 'MuScale'을 제안하고, 6명의 참여자를 대상으로 2주간 그들의 집에 설치하여 실험을 진행하였습니다.

그 결과, 참여자들은 각각 다른 무게에 잠재적 목표와 오랜 경험이 쌓여서 만들어진 취향을 투영하였습니다. 무게를 투영하여 플레이리스트를 구성하는 과정에서 심리적 소유감의 요건을 충족하였습니다. 그 후, 사용 과정을 통해 자기 투영 및 반사와 청취 경험에서의 심리적 소유권이 나타나는 4가지 측면이 나타나는 것을 발견하였습니다.

물리적으로 분리된 플레이리스트는 사용자들이 반복 작업을 통해 완벽한 구성 혹은 추가 소비를 불러일으켰습니다. 반면에, 잠재적 목표와 그로부터 느낄 수 있는 가치를 유지하기 위해 사람들은 신중한 소비를 하였습니다. 무게라는 것이 언어적 의미와 결합되어 사람들에게 자기 반영을 불러일으킬 수 있는 기회와 가능성을 제시했습니다. 더 나아가, 사람들과의 관계에서 무게의 세분화에 대한 기준과 그것에 대한 호기심을 통해 집중된 시간을 제공하고 , 관계 향상을 촉진하는 것으로 보아, MuScale은 새로운 인터랙션 방법으로 사람들에게 대화의 매개체로 작용할 수 있는 가능성을 확인할 수 있었습니다.

연구자들은 많은 것이 디지털화된 컨텐츠 시장에서, 디지털 컨텐츠를 통해 적극적으로 나의 성격과 취향을 표현하고 친구 및 공동체를 이루는 사람들과의 능동적이고 원활한 커뮤니케이션이 가능한 디자인을 해야 한다고 강조합니다. 우리의 연구결과는 미래의 뮤직 플랫폼에서 사람들이 플레이리스트를 단계별로 세분화하고 자기 투영 및 사회적 공유를 위한 서비스를 설계함으로써 디지털 컨텐츠에 대한 감정적 애착 향상을 위한 새로운 고려사항으로 제안될 수 있으며, 현대 사회에서 라이프 스타일과 취향이 담긴 디지털 컨텐츠를 유형화하는 것에 대한 가치와 가능성을 제공할 수 있습니다.

핵심어: 심리적 소유감, 디지털 음악, 재물질화, 감정적 애착

ACKNOWLEDGEMENT

먼저, 2 년동안 지도해주신 김차중 교수님께 감사 인사를 드립니다. 덕분에 연구라는 새로운 분야에 대해 몸소 배우고 성장할 수 있었습니다. 그리고, 부족한 저에게 늘 격려해주시고 아낌없는 응원 해주신 박영우 교수님께도 진심으로 감사하다는 말씀을 드리고 싶습니다. 유익한 수업과 더불어 함께 고민하고 완성해나가는 과정을 통해 평생 잊지 못할 경험을 할 수 있었고, 연구자이자 디자이너로서 크게 성장할 수 있었습니다. 그리고, 항상 아버지같이 애정 어린 시선으로 지도해주시고 따뜻하게 격려해주신 이희승 교수님께도 깊은 감사 인사 전하고 싶습니다. 훌륭한 교수님들의 지도 아래에 졸업 연구를 마무리 할 수 있었습니다. 뿐만 아니라, 관심을 가지고 항상 자신감을 가질 수 있도록 격려해주신 이경호 교수님께 감사 인사를 드립니다. 그리고, 아낌없는 조언과, 격려해주신 김관명, 정연우, James Andrew Self, 김황, 박이승호 교수님께도 감사하다는 말씀 전하고 싶습니다. 보이지 않는 곳에서 언제나 힘 써주시고, 응원해주신 김효진, 강우정 선생님, 그리고 부족한 저를 항상 가르쳐주시고 옳은 방향으로 지도해주신 육기철 선생님께도 깊은 감사 인사 드립니다.

그리고 2 년이라는 시간 동안 즐거울 때, 힘들 때 항상 옆에서 응원해주고, 함께 울고 웃은 Emotion Lab 조광민, 마상현, 강혜민 님께도 감사인사 드립니다. 그리고 2 년동안 큰 힘이 되어준, 나보다 더 언니같은 석사 동기 주소미. 덕분에 무슨 일이든 긍정적인 에너지로 임할 수 있었고, 행복한 2 년을 보냈습니다. 우리 참 여러 곳곳 함께 다녔는데, 졸업 후에도 알콩달콩 즐거운 나날들만 가득하길 바랍니다. 동갑내기 친구이자, 나의 멘토였던 이경룡에게도 감사 인사를 드립니다. 함께 했던 여러 작업과 성과들, 평생 잊지 못할 팀웍으로 기억될 것 같습니다. 둘과 함께 했던 티타임이 그리워질 것 같네요. 서로에게 좋은 영향을 줄 수 있어서 더 뜻 깊었던 시간이었습니다. 그리고 늘 웃음짓게 해주는 김재원, 항상 웃으며 응원해주는 이지영, 배려심 깊은 장성원, 무한 애정 박소윤, 마음 따뜻한 장상수, 웃음을 잃지 않는 수빈이, 분석왕 주상진 오빠, 기분 좋은 에너지를 주는 김보민 등 CDE 선배 후배님들 모두 감사합니다. 그리고, 연구실 선배님 이자, 저의 사수이셨던 배지은 선생님께도 감사하다는 인사 드립니다. 마지막으로, 항상 묵묵히 응원해주시는 사랑하는 가족들, 친구들에게도 감사의 말씀을 전합니다.

유니스트에서 보낸 시간은 빠르게 흘러갔지만, 모든 순간이 선물 같았고, 생생하게 기억이 납니다. 석사 생활 동안 이룬 모든 결과 속에는 많은 분들과 함께 고민하는 과정이 있었으며, 인생에서 너무나도 소중한 경험으로 남겨질 것 같습니다. 끝은 곧 새로운 시작이라는 말이 있습니다. 새로운 시작을 위해 힘써주신 많은 분들께 진심으로 감사드리며, 앞으로의 미래에도 항상 밝은 일만 있기를 진심으로 기원할 것입니다.

This work was supported by the 'Promotion of Special Design-Technology Convergence Graduate School' of the Korea Institute of Design Promotion with a grant from the Ministry of the Trade, Industry & Energy, Republic of Korea.(N0001436)

MuScale: Designing for Tangible Interaction with Weight in Digital Music Experience